

Magnification in panoramic radiography

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ABSTRACT

Background: It is known that the image of panoramic radiograph is larger than the structure it represents.

Materials and methods: To quantify the magnification of the machine used in this study (Cranex 3+), horizontal curved wire of 150 mm. was fixed by wax on a dry skull between maxilla & mandible. Other 30 mm. long wires were fixed vertically, one in the midline & the others in the canine, premolar & molar regions bilaterally. The skull was positioned as the patient's head positioned so the area to be exposed is precisely within the zone of sharpness, the films were processed & the radiographs were viewed.

Results: A comparison between real & radiographic wires length was done. The result revealed that horizontal magnification was 6.6-10%, while the vertical magnification was 26.6-30%, but the machine rotation was symmetrical.

Conclusion: Carnex 3+ X-ray machine had a symmetrical rotation with 26.6-30% vertical magnification & 6.6-10% horizontal magnification.

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INTRODUCTION

Panoramic radiograph is an essential aid in the evaluation of the oral health & detection of oral lesions, so it is important for prevention & interception of incipient abnormalities which may be seen quite well.

In recent years, there has been an increase in the types of panoramic machines offered to the dental profession.

Many of these machines use different X-ray beam rotation centers & they can produce panoramic radiographs that vary between the machines. The individual dentist must know exactly what layer of the patient his panoramic machine examines & must be aware that pantomogram by machines of another manufactures must be interpreted differently, because the path of effective rotating center & the positions & shapes of focal layers are different in every unit which has a critical influence on image quality ⁽²⁾.

In rotation panoramic radiography, x-ray tubes to object distance & object-film distance factors control the degree of vertical magnification.

However, horizontal magnification has an important additional factor, namely, the speed of the film in relation to the speed of the x-ray beam at object point. Most manufacturers try to control the film speed to produce constant vertical & horizontal magnification over the whole film ^(3,4).

Many studies were done to evaluate the magnification of different panoramic x-ray machines. Sattayasansskull, et al, showed that an image magnification approximately 36% occurs in the vertical plane in the incisor & premolar region, but that the degree of magnification increases to 39% in the molar region. In the horizontal plane, the degree of magnification is more variable, ranging from 15% in the incisor region to 23% in the premolar region & decreasing to 21% in the molar region. ⁽⁹⁾

The machine that was used in this study is Panorex OP3E, Siemens Ltd x-ray machine.

Uthman concluded that the Orthopantomograph 5 panoramic x-ray machine rotation is symmetrical & has a magnification ratio between (1.1-1.5) ⁽⁵⁾. PM 2002cc Proline by Planmeca reported in its technical specifications that a constant 1.2 of magnification was shown in its panoramic radiograph ⁽⁶⁾. Proscan panoramic x-ray machine which is also by PLANMECA SHOW A MAGNIFICATION RATIO of constant 1.2.

MATERIALS AND METHOD

Dry human skull was used as a model for this study, area of maxilla & mandible was covered by 3/4 inch of modeling wax simulating soft tissue to have the same density as normal human being ^(7,8).

An orthodontic stainless steel wire gauge 0.9 mm was used. A wire of 150mm. length was curved following the curvature of dental arch & fixed horizontally by sticky wax between maxilla & mandible. A 30 mm wire was fixed vertically in the midline of the two arches (m). Other six wires of 30 mm long were fixed vertically by sticky wax by the following way:

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First wire (a) at a horizontal distance of 15 mm from (m) on both sides (passed at canine region).

Second wire (b) at a horizontal distance of 10 mm from (a) on both sides (passed at premolar region).

Third wire (c) at a horizontal distance of 10 mm from (b) on both sides (passed at molar region).

To quantify the magnification of the machine used in this study, the skull was positioned as a patient's head positioned normally, exposed to X-ray, then the film is processed & viewed.

The radiographic lengths of the wires were measured & compared with their real lengths as follows:

1. Vertical lengths of m, a, b & c.
2. Total length of the horizontal curved wire.
3. Horizontal length of ma, ab & bc on both sides.

Those measurements were compared with the measurements obtained using different types of panoramic machines.

RESULTS AND DISCUSSION

The results obtained for image magnification are given in table (1) & (2).

They show that the image magnification of approximately 30% occurs in the vertical plane in the incisor region, but the degree of magnification decreases to 26.6% in canine, premolar & molar regions (table 1). In the horizontal plane the degree of magnification of the total curved wire was 8% (table 2). A previous study done by Sattayanskull et al, ⁽⁹⁾ on Panorex OP3E, Siemens Ltd X-ray machine. They reported that 36% of vertical magnification are in the incisor & premolar regions which increases to 39% in the molar region, whereas horizontal magnification were more variable, ranging from 15% in the incisor region to 23% in the premolar region then decreasing to 21% in the molar region. Uthman ⁽⁵⁾ determined the accuracy & symmetry of the image produced by the siemens orthopantomograph 5 panoramic x-ray machine, and he concluded that the machine rotation is symmetrical & has a horizontal magnification (1.1-1.5), 11.7% for total

horizontal curved wire, 50% in the incisor region, 30% in the premolar region, & 10% for molar region, while orthopantomograph 10 has an average magnification of 21.1% in the vertical dimensions & 20.5% in the horizontal dimensions.

The characteristics of the Orthopantomograph OP 100 was studied by Scarfe, et.al ⁽¹¹⁾, they reported that the vertical magnification factor within the focal trough showed a linear increase along the beam path from (1.24-1.37) & the horizontal magnification varied from (1.01-1.63). Land & Manson Hing used radiographs of Panorex, Orthopantomograph 3, & GE 3000 panoramic x-ray machines to evaluate & compare the magnification factors of them. ⁽³⁾ Vertical magnification of Orthopantomograph 3 with a range of 23.2% & the Panorex with a range of 17.1% displayed a greater range than the 9.8% of GE 3000. The ranges are much larger horizontally, & the Panorex's range of 64% greater than that of GE 3000 with 56% & the Orthopantomograph 3 with 52%. Planmeca PM 2002 CC Proline & Planmeca proscan Panoramic x-ray machines provides undistorted radiographs that maintains 1.2 constant diagnostic measurements. These variations in the results are related to the path of effective rotating center, source-image receptor distance, object-film distance & the positions & shapes of focal layer. Those factors are different to each unite so the resultant magnification is specific for each panoramic x-ray machine. Most Panoramic units designed to exposed a fixed elliptical shape of focal trough. This type of shape does not correspond to the human jaw, particularly in the lateral part of the jaw areas that conform to the elliptical shape can be seen clearly on the radiographs. The size & shape of the human jaw varies considerably depending on the patient's size, race & sex. So it is better to have form of the focal trough is adjustable & can be selected to correspond to the patients anatomy & the object to be radio graphed. Planmeca x-ray machine (6) provides nine different combinations of size & shapes to adjust the focal trough to fit the patients arch form.

Size: Small-Medium-Large.

Shape: Narrow-Average-Wide.

Table 1: Vertical magnification of long steel pins placed in dried skull & recorded in OPG using Carnex 3+ X-ray machine.

Length mm	m		a		b		c	
	real	Radiological	real	Radiological	real	Radiological	real	Radiological
Magnification %	30	39	30	38	30	38	30	38
	30%		26.6%		26.6%		26.6%	

Table 2: Horizontal magnification of long steel pins placed in dried skull & recorded in OPG using Carnex 3+ X-ray machine.

Length mm	Ma		Ab		Bc	
	real	Radiological	real	Radiological	real	Radiological
Magnification %	51	61	10	11	10	11
	6.6%		10%		10%	

Total horizontal wire length= 150mm

Radiographical length=162mm

% magnification= 8%

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